

Monitoring Sea Level by Tide Gauges and GPS at Barcelona and Estartit Harbours

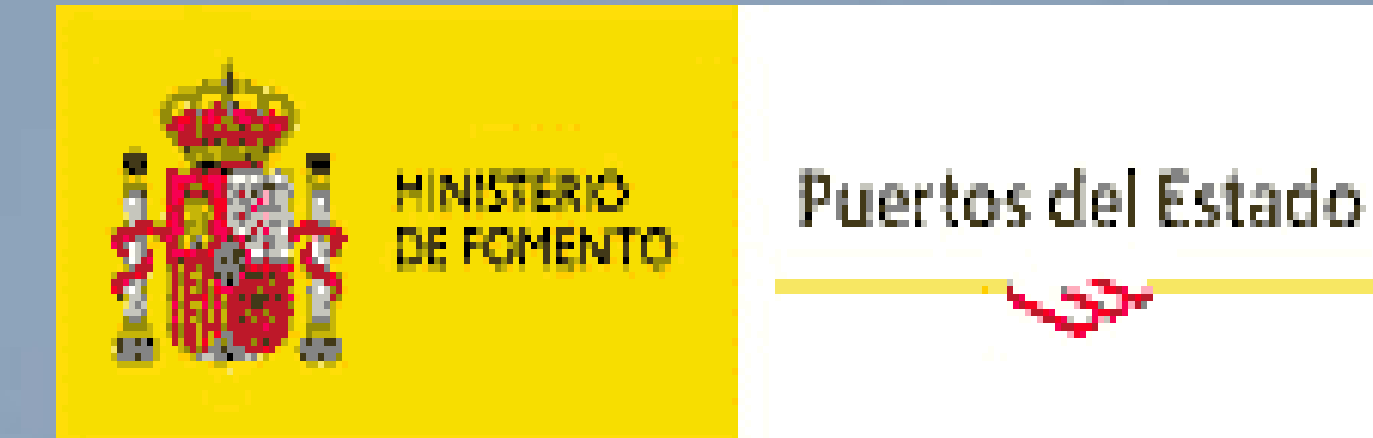
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Abstract

Sea level is an environmental variable which is widely recognised as being important in many scientific disciplines as a control parameter for coastal dynamical processes or climate processes in the coupled atmosphere-ocean systems, as well as engineering applications. A major source of sea-level data are the national networks of coastal tide gauges, in Spain belonging to different institutions as the Instituto Geográfico Nacional (IGN), Puertos del Estado (PE), Instituto Hidrográfico de la Marina (IHM), etc.

The tide gauge of l'Estartit is a traditional floating gauge placed 21 years ago and has an accuracy of ± 2 mm. Since 1996, l'Estartit tide gauge has been co-located with geodetic techniques (GPS measurements of XU, Utility Network, and XdA, Levelling Network,) and it is tied to the SPGIC (Integrated Geodetic Positioning System of Catalonia) project of the Cartographic Institute of Catalunya (ICC).

In 2006, due to the work for the expansion of the harbour, the tide gauge had to be moved. Before the work started, appropriate GPS measurements were carried out in order to ensure the connection of the tide gauge data. During October 2006 and May 2008, the tide gauge was inactive and it has been moved on to a new location inside the harbour. In June 2008, new GPS and levelling measures have been done in order to tie the new location into SPGIC project and to co-locate old data respect the new one.

At Barcelona harbour there is one MIROS radar tide gauge belonging to Puertos del Estado (Spanish Harbours). It is placed at the dock 140 of the ENAGAS Building. The radar sensor is over the water surface, on a L-shaped structure which elevates it a few meters above the quay shelf. 1-min data are transmitted to the ENAGAS Control Center by cable and then sent each 1 min to Puertos del Estado by e-mail. This sensor also measures agitation and sends wave parameters each 20 min. A provisional tide gauge bench mark has been defined while the levelling has been done. There is a GPS station Leica Geosystems GRX1200 GG Pro and antenna 1202. Bathymetric campaigns inside the harbour have been made.

1.- L'ESTARTIT and BARCELONA TIDE GAUGES

L'Estartit Harbour



The tide gauge of l'Estartit is a traditional floating gauge placed 18 years ago and has an accuracy of ± 2 mm. Since 1996, the l'Estartit tide gauge has been co-located with geodetic techniques (GPS measurements of XU, Utility Network, and XdA, Levelling Network,) and it is tied to the SPGIC (Integrated Geodetic Positioning System of Catalonia) project of the Institut Cartogràfic de Catalunya (ICC).

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In June 2008, new GPS and levelling measures have been done in order to tie the new location into SPGIC project and to co-locate old data respect the new one. A significant contribution has been made related to Topex/Poseidon and Jason-1 calibration campaigns, direct and indirect, using GPS buoys, in March 1999, August 2000 and July 2002 near Cape of Begur.

Although l'Estartit does not have a GPS permanent station, it is possible to build a virtual one from the service "CATNET web" of the ICC. "CATNET web" is a data distribution system of a virtual GPS permanent station via web. From the coordinates where you want to place the virtual station, the time interval and the measurement rate, the system generates a RINEX file under the requested conditions.

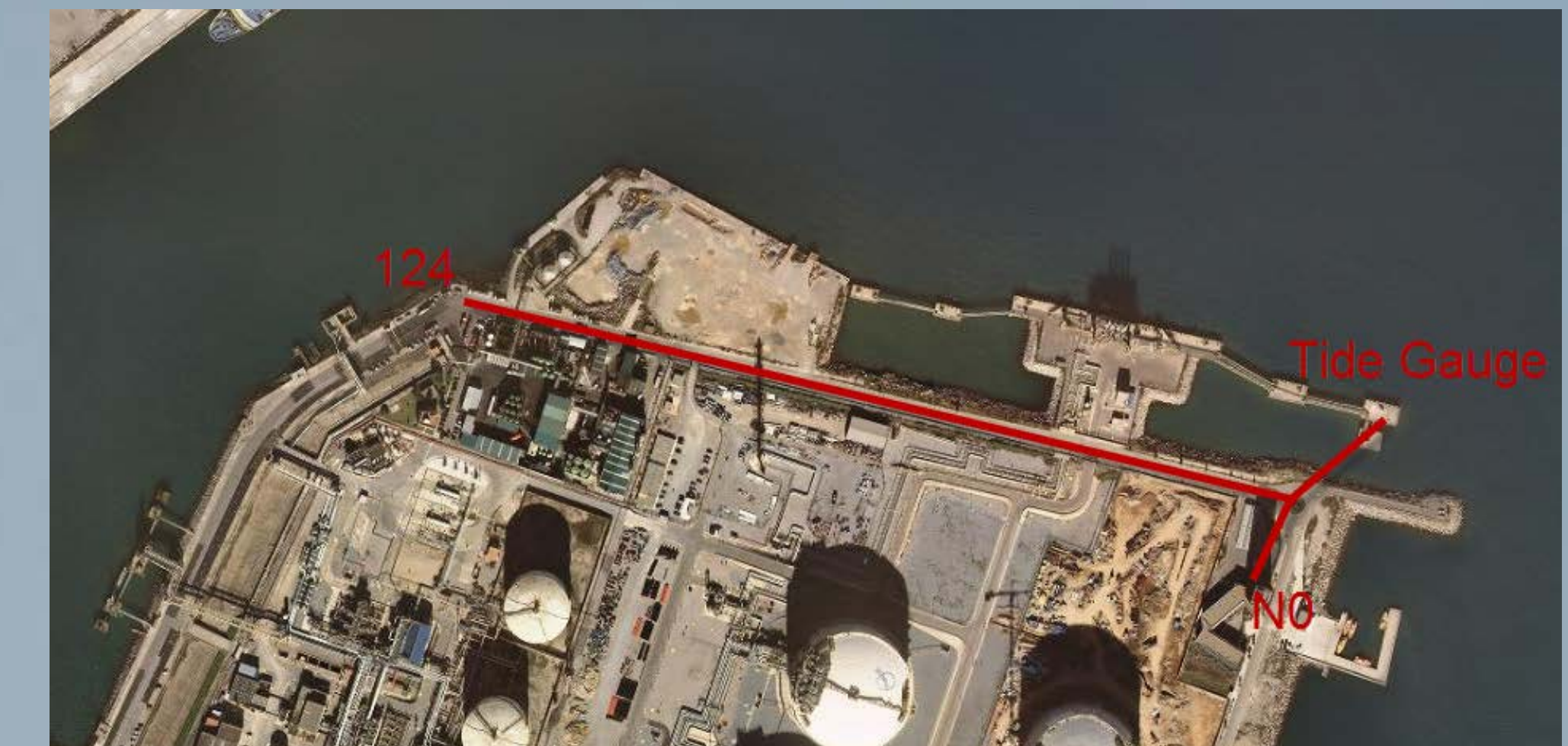


code ; type of data; longitud; latitude; el-lipsoidal height
314094002; XU-ICC20060; 3.2067323; 42.0538927; 50.881
314094002; RTKAT-2006; 3.2067322; 42.0538928; 50.851
314094003; RTKAT-2008; 3.2060021; 42.0533614; 50.491
314094064; XU RTKAT-2006; 3.2063734; 42.0535306; 50.664
314094064; XU RTKDAT-2008; 3.2063735; 42.0535309; 50.677

Barcelona Harbour



CGPS Levelling Barcelona Harbour



The new Control Tower was erected by the Port of Barcelona Authority (APB) and is under operation since June 2008. At the top of its 45 meters, among other devices and systems, the APB has a GPS Permanent Station. The Antenna Reference Point (ARP) of the GPS was levelled within both campaigns.

In the 2011 campaign, the traverse started at point #124, which belongs to the local levelling network (XdA, maintained by the Institut Cartogràfic de Catalunya, the local geodetic authority). From this fiducial point, the levelling traverse reached point #121, where the traverse splits into two arms: the first one (105 m) links with the Tide Gauge (actually, with the iron pin #146 at its foundation); the second levelling arm (60 m) proceeds up to NO point at the main entrance of the Control Tower.

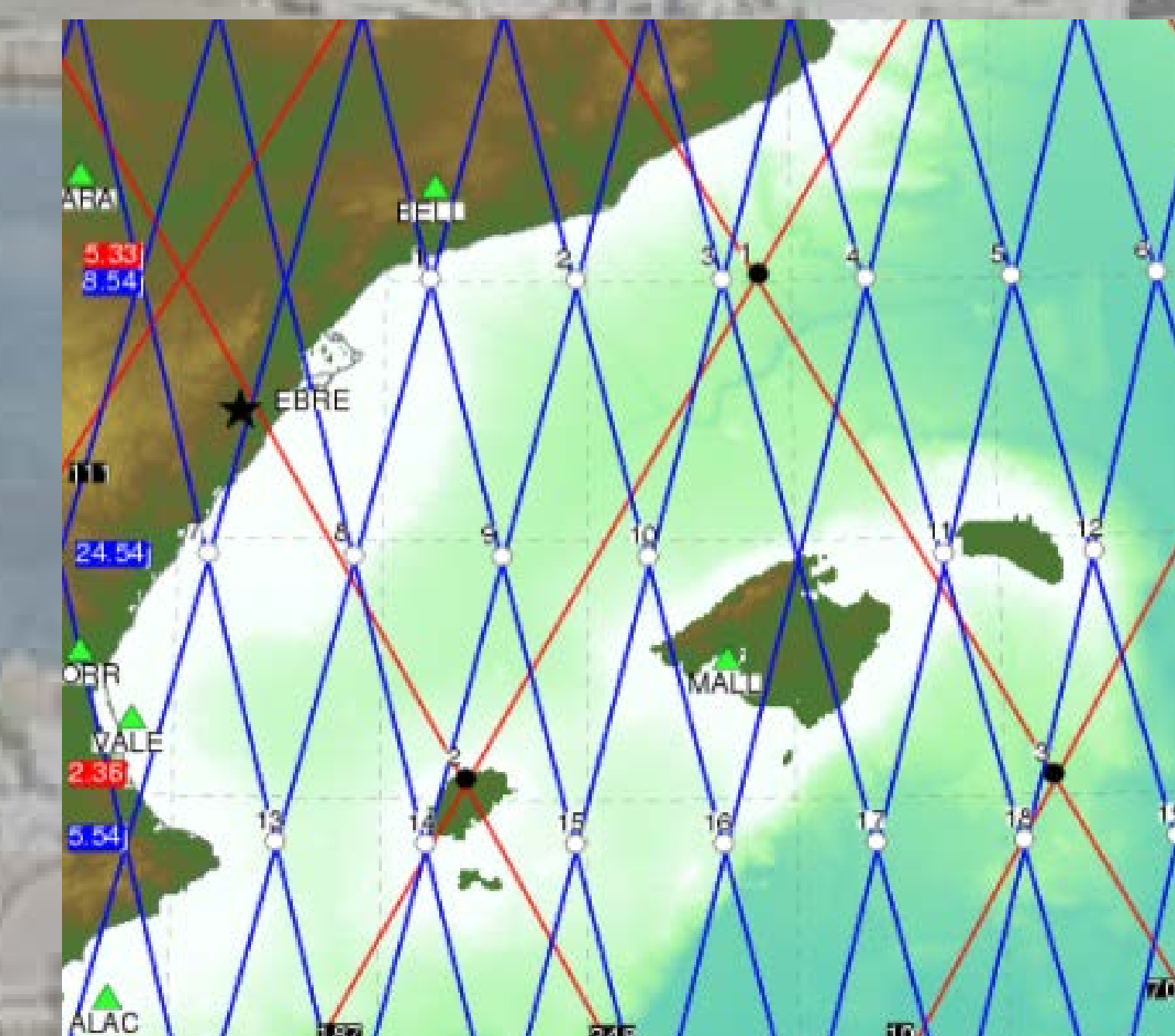
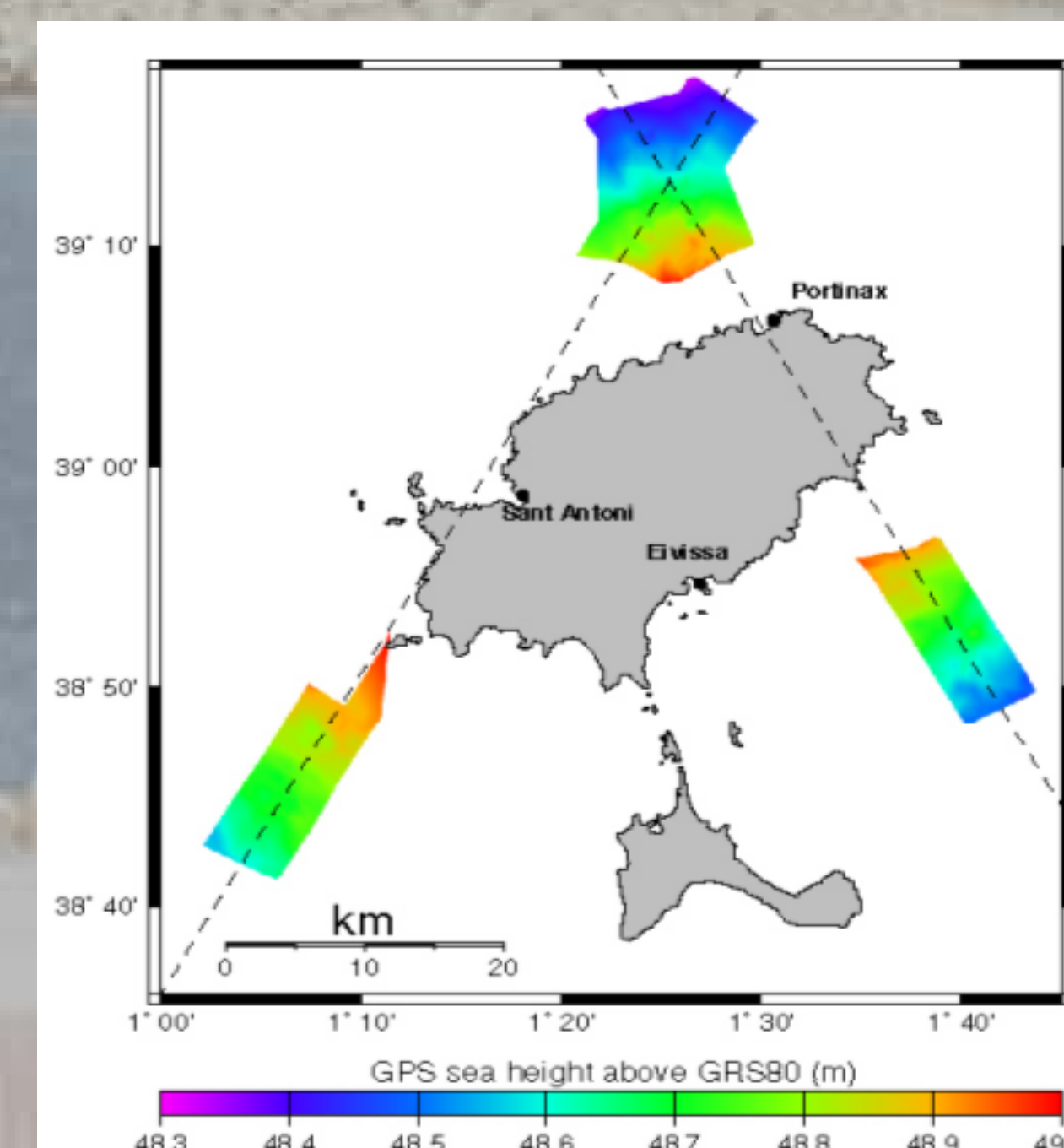
To confirm the overall tower height measurement and to gain confidence in the general setup in use, an independent height measurement was conducted using GPS levelling. A 3-hour logging session (Fast Static GPS relative method) was carried out with 3 GPS receivers: 2 Topcon Hiper-Pro receivers set up over point #146 and point #130 (quite close to #124); the third one was the Leica receiver that conforms the GPS Permanent Station itself (consequently, its antenna is the one over the ARP point). The GPS levelling, although is less precise, confirmed the overall results: the precise levelling between points #124 and ARP gave us a change in elevation of 46.484 m, whereas the GPS levelling obtained only 6-mm difference.

Table: Partial comparison of the 2009 and the 2011 levelling campaigns. H is the orthometric height of the points (referenced to the Mediterranean Mean Sea Level at Alicante Harbour, Spain, through the local levelling network)

Point	H 2009(m)	H 2011(m)	Difference(mm)	Point description
124	4.3326	4.3326		Main point where the comparison starts
NO		5.2861		Control Tower main entrance (ground level)
ARP	50.8781	50.8901	+12.0	Antenna Reference Point of the GPS Station

2. Contribution to Jason-2 and SARAL/AltiKa Missions

The main objective for the Geodetic Infrastructure of Barcelona and l'Estartit harbours, together with the main site of Ibiza harbour, is their scientific contribution to the marine campaign of 2013. A possible geographic area would be the west Mediterranean Sea (image courtesy of Dr. Richard Biancale/François Fund (CNES/LEGOS). It is possible to make in part a campaign like IBIZA2003 (image courtesy of Dr. Pascal Bonnefond et al., OCA/GRGS).



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